FACTORS FACILITATING THE MOVEMENT OF SPERM IN THE FEMALE REPRODUCTIVE TRACT

The complex process of sperm transport through the female reproductive tract begins at the time of ejaculation. During coitus, 1.5- to 5.0-ml of semen containing between 200 and 500 million sperm is deposited at the posterior vaginal fornix, leaving the external cervical os partially submerged in this pool of fluid.

At coitus, human sperm are deposited into the anterior vagina, where, to avoid vaginal acid and immune responses, they quickly contact cervical mucus and enter the cervix. Cervical mucus filters out sperm with poor morphology and motility and as such only a minority of ejaculated sperm actually enters the cervix. In the uterus, muscular contractions may enhance passage of sperm through the uterine cavity. A few thousand sperm swim through the uterotubal junctions to reach the Fallopian tubes (uterine tubes, oviducts) where sperm are stored in a reservoir, or at least maintained in a fertile state, by interacting with endosalpingeal (oviductal) epithelium. As the time of ovulation approaches, sperm become capacitated and hyper activated, which enables them to proceed towards the tubal ampulla. Sperm may be guided to the oocyte by a combination of thermo taxis and chemo taxis. Motility hyper activation assists sperm in penetrating mucus in the tubes and the cumulus oospores and zona pellucida of the oocyte, so that they may finally fuse with the oocyte plasma membrane.

Factors include:

1. CERVICAL MUCUS: Cervical mucus is continuously secreted through exocytosis by the nonciliated epithelial cells that line the cervical canal. This biomaterial serves many important functions, including exclusion of seminal plasma, exclusion of morphologically abnormal sperm, and support of viable sperm for subsequent migration to the uterus and oviduct. It is a heterogeneous fluid with both high- and low-viscosity components. The amount of mucus produced and its composition and characteristics fluctuate with circulating progesterone and estrogen levels. As estrogen levels peak at midcycle, cervical mucus is abundant in volume and thin in consistency because of increased water content. Under the influence of progesterone, water content decreases, and the mucus has a much higher viscosity.

Sperm movement through the cervical mucus is primarily through the interstitial spaces between the mucin micelles, and the sperm's progression depends on the size of these spaces. The size of the interstices is usually smaller than the size of the sperm heads; thus, sperm must push their way through the mucus as they proceed through the lower female genital tract.

Besides hormonal factors, physical processes, such as shearing, stretching, and compression can alter the spaces between molecules and, consequently, orientation of the mucin filaments. These mechanical forces can be imparted by thrusting and pelvic contraction during coitus, and also by cervical contractions in the pericoital period. Additionally, rheological forces associated with the mucus outflow from the cervical crypts tend to align the mucin filaments in a longitudinal fashion within the cervical canal, thus creating aqueous channels between the filaments. Given this longitudinal orientation, with mucus outflow originating in the crypts of the cervical epithelium, it has been postulated that sperm are constrained to swim in the direction of least resistance, that is, along the tracts of mucus outflow in the direction of the cervical crypts. Using mucus stretched in vitro, several investigators have indeed demonstrated the parallel swimming patterns of sperm. This theory complements the notion that spermatozoa entering the cervix are directed toward the cervical crypts, the site of mucus secretion that serves as a possible storage reservoir. Spermatozoa may retain their fertilizing capacity in human cervical mucus for up to 48 hours and their motility for as long as 120 hours. From their temporary storage location within the cervical crypts, sperm can be released gradually over time, thus enhancing the probability of fertilization.

1. Sperm movement through the Fallopian tube relies on a combination of forces: intrinsic sperm motility, tubular muscular contraction, and fluid flow.
2. MUSCULAR CONTRACTIONS: Transport of sperm through the uterus is likely aided by pro-ovarian contractions of the myometrium. In humans, contractile activity of uterine muscle may draw sperm and watery midcycle mucus from the cervix into the uterus. Rapid transport of sperm through the uterus by myometrial contractions can enhance sperm survival by propelling them past the immunological defenses of the female.
3. OTHER FACTORS: Mating behavior, the seminal plasma, the spermatozoa, the female reproductive tract (musculature, secretions, epithelial cell surfaces), the products of ovulation (oocyte, oocyte investing layers, follicular fluid), and immunocompetent elements of the female reproductive tract.

All these factors interplay to establish the transport and distribution of sperm within the reproductive tract, and they control the physiology of the heterogeneous sperm population to ensure successful fertilization. These primary factors are modulated by the endocrine and nervous systems.